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Deficient Health Knowledge, Diet, and Other Lifestyles in Smokers: Is a Multifactorial Approach Required?[1]

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Background. **Data from the Scottish Heart Health Study, a random cross-sectional sample of middle-aged men and women, are used to compare health knowledge, behavior, and lifestyles between 4896 smokers and 4595 nonsmokers.**

Methods. **Smokers are identified from self-reports with biochemical validation. They are compared with nonsmokers using analysis of covariance and logistic regression, adjusting for age and social class.**

Results. **Smokers are found to have poorer dietary knowledge than nonsmokers, although both groups are well-informed on some aspects of diet. Knowledge of personal risk modifiers for coronary heart disease and recent intention to improve lifestyle are both worse among smokers. Smokers have lower intakes of the antioxidant vitamins and fiber, but higher intakes of dietary cholesterol and alcohol than nonsmokers. They also tend to have higher salt intake and eat a greater proportion of saturated fat, butter, or hard margarine, and full-fat milk. High-density lipoprotein cholesterol levels are lower, but triglycerides, fibrinogen, and, for women only, total serum cholesterol levels are higher among smokers. On the other hand, body mass index and diastolic blood pressure are lower among smokers.**

Conclusions. **In addition to advice to give up smoking, smokers should be counseled to improve their diet. The positive message to eat more fresh fruit and vegetables would be particularly helpful.**

INTRODUCTION

Smoking is widely accepted as an unhealthy behavior, indicted in the etiology of many diseases, including cardiovascular disease (CVD), respiratory diseases, cancers, diabetes, ulcers, osteoporosis, and problematic conditions associated with pregnancy. What is less well understood is the extent to which smoking is a marker for a generally unhealthy lifestyle. This is an important consideration for several reasons. First, general practitioners may be advised to counsel smokers with, for example, special dietary advice, in addition to advice to give up smoking. Second, health education on aspects other than smoking, may be more effective if targeted at smokers. Third, smoking cessation programs may be more effective if combined with a more general aim of improving health awareness. Finally, if smoking is typically part of a generally unhealthy lifestyle, then the harmful effects of smoking may be exaggerated, unless the other lifestyle factors are accounted for, in any epidemiological investigation.

In this article we compare both the health awareness and behavior of smokers and nonsmokers from a large sample of Scottish men and women. Objective biochemical evidence is used to validate the definition of a "nonsmoker." Health awareness is an important consideration if we are to ascertain whether certain health promotion activities should be targeted at smokers. Healthy behavior here encompasses a range of lifestyle variables already linked to cardiovascular disease, identified by the UK government as a crucial target for health promotion activities (1). Many of these variables have also been suggested as risk factors for other leading causes of death and illness among adults in industrialized countries. In particular we look at the relationship between smoking and some key aspects of diet.

MATERIALS AND METHODS

The cross-sectional survey used is the baseline random population sample from the Scottish Heart Health Study (2–4). The sample comprised 10,359 men and women, age 40–59 years, from 22 districts in Scotland between 1984 and 1986. Recruitment was obtained through general practitioners (5), and an overall response rate of 74% was obtained from those contactable by mail.

Subjects were sent a questionnaire to complete at home, which included questions about current smoking, health awareness, age, occupation, and physical

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activity plus a food frequency questionnaire. The food frequency questionnaire was adapted from that established by the Medical Research Council's Epidemiology Unit (South Wales) (6). It ascertains how many days a week the individual eats each of a wide range of food items. Fats, cheese, cream, and table sugar were based on family consumption. From the answers daily nutrient intakes were computed using standard portion sizes and food composition tables (7). Further details are given elsewhere (8, 9). The questionnaire also included some simple questions on food preference for type of milk usually used (full-fat or skimmed/semiskimmed), type of fat usually eaten on bread (butter/hard margarine, or soft margarine), and amount of salt generally added to food. The latter was established here from the question "Is, in your opinion, readymade food compared to homemade food less salty/as salty/more salty?"

The physical activity question analyzed here is "Would you say, in your leisure time, you are: active/average/inactive?" For analysis purposes "active" and "average" responses were combined.

The questions about health awareness are listed in Table 1. These split into three subsections designed to discover health knowledge in a personal context, general dietary knowledge, and commitment to improving personal health. All questions solicited "yes" or "no" answers, with the question on alcohol also allowing a "doesn't apply" response. The dietary questions were deliberately chosen to include both true and false assertions.

Besides completing the questionnaire, subjects were asked to attend a physical examination where height, weight, blood pressure, and the carbon monoxide (CO) content of the subject's expired air were measured (10), and a blood sample was taken by trained nurses. Serum was used to estimate total cholesterol by enzymatic means and HDL-cholesterol using dextran sulfate/magnesium chloride precipitation. Serum cotinine was estimated by gas–liquid chromatography (11, 12) and serum thiocyanate (SCN) was estimated on a COBAS Bio centrifugal analyzer (12). Plasma was used to estimate fibrinogen by the thrombin time method (13), using a Coag-A-Mate coagulometer.

In this article a "smoker" is any subject who has a self-reported current consumption of cigarette, cigar, or pipe tobacco (either as a regular or occassional smoker). "Nonsmokers" are taken as all others, with the exception of any person with biochemical evidence of smoking. These are all those self-declared nonsmokers with CO in expired air of 6 ppm or above, serum cotinine of 17.5 ng/ml or above, or SCN of 63.4 μmol/liter or above, the optimum cut points for distinguishing true nonsmokers from apparent deceivers for the current data (14). By making these exclusions we hope to have achieved a group of true nonsmokers, uncontaminated by deceivers.

Statistical comparisons between smokers and nonsmokers were adjusted for age and social class. Health behaviors vary substantially by age, so that it is important to rule out age as the explanation for the observed differences between smokers and nonsmokers (15). Similarly, we have previously shown that smoking, an unhealthy diet, and other indicators of disease-risk are higher in the less advantaged social groups in Scotland (9, 16). Social class was measured using the six-point scale derived from occupation by the Office of Population Censuses and Surveys (17). For employed men and single women the definition was direct. For unemployed men the last occupation, and for married women the husband's occupation, determined the social class.

Adjustments by age and social class for continuous variables were achieved by analysis of covariance, preceded by a suitable transformation in the case of skewed variables. For binary variables, logistic regression models were fitted and the reductions in deviance after adding smoking status to the model already containing age and social class were evaluated (18).

TABLE 1

The Questions on Health Knowledge and Behavior

Do you think the following may reduce your chance of having a heart attack?
Relaxing more
Taking exercise
Eating less fat
Losing weight
Do you agree with the following statements?
Full cream milk is better for you than skimmed milk
Fried food is better for you than grilled food
Dairy products have a lot of fat
Bread and potatoes are fattening
Soft margarine is better for you than butter
Over the last year, have you tried to:
Lose weight
Eat less fat
Eat less salt
Drink less alcohol
Take more exercise

Note. All questions allow yes/no responses. The question regarding alcohol also allows a response of "doesn't apply."

RESULTS

Of the 10,359 subjects sampled, 868 were excluded from the analysis because they were self-reported nonsmokers with biochemical evidence of smoking. Table 2 shows the distribution of the remaining 9491 by smoking status, social class, and sex. Besides nonrespondents, the "unclassified" social class group includes single women "homemakers."

Overall 13% more men than women were smokers. There is a clear trend in the percentage that smoke by

TABLE 2

Number of Subjects Classified by Occupational Social Class, Smoking Group, and Sex

Social class	Men			Women		
	Nonsmokers	Smokers	% Smokers	Nonsmokers	Smokers	% Smokers
I Nonmanual professional	198	141	42	250	64	20
II Nonmanual intermediate	675	561	45	783	360	31
IIIn Nonmanual skilled	226	223	50	384	243	39
IIIm Manual skilled	727	1106	60	739	726	50
IV Manual partly skilled	241	385	62	326	334	51
V Manual unskilled	72	158	69	120	127	51
Unclassified	13	41	76	142	126	47
Total	2152	2615	55	2744	1980	42

social class, especially among men, with the least-advantaged classes having the highest percentage of smokers. Within the small age range used in the study, the differences in average age are small (49.3 years for smokers and 50.0 years for nonsmokers among men, and 49.2 years and 49.6 years, respectively, among women). These differences are nevertheless, significant ($P < 0.001$ for men; $P = 0.022$ for women). Both age and social class are significant predictors of most of the lifestyle variables considered later (with $P < 0.001$ in many instances). Hence there is empirical justification for adjusting for age and social class when considering the effect of smoking on lifestyle.

Table 3 shows the number and percentage answering "positively" to the questions listed in Table 1. That is, those who have said yes to the questions on what may reduce their risk of a heart attack and their actions over the last year. Those with the correct answers to the health knowledge questions are also included as positives. The percentages are calculated relative t the number who actually answered each question, ex cept that the "doesn't apply" respondents are omitted from the alcohol question. In each case there are a relatively small number of nonrespondents. With the exception of the alcohol question, a lower percentage of smokers answer positively to every question. Although more smokers have tried to drink less alcohol in the past year there is no significant difference ($P > 0.10$) between smokers and nonsmokers in this respect, with or without adjustment for age and social class.

For the first set of questions (on what may redu personal risk of a heart attack), all the smoker vs non-

TABLE 3

Percentage Answering Positively to Questions on Health Knowledge and Behavior by Smoking Group and Sex

	Men			Women		
	% Nonsmokers	% Smokers	P value[a]	% Nonsmokers	% Smokers	P value[a]
Can you reduce risk?						
By relaxing more	63	60	*	71	67	*
By exercising	80	73	***	79	67	*
By eating less fat	81	76	***	79	74	***
By losing weight	72	58	***	75	67	***
Health knowledge						
Milk	84	75	***	88	84	***
Fried food	98	96	*	99	98	NS
Dairy fat	93	91	*	92	90	*
Bread/potatoes	53	50	NS	59	52	*
Margarine	67	62	***	62	59	*
Over the last year tried to						
Lose weight	38	23	***	61	45	
Eat less fat	53	42	***	67	55	
Eat less salt	36	26	***	39	29	***
Drink less alcohol	26	29	NS	25	28	NS
Take more exercise	40	35	***	45	38	***

[a] P values are adjusted for age and occupational social class. NS, $P > 0.10$.
* $0.01 < P < 0.05$.
*** $P < 0.001$.

smoker differences are significant ($P < 0.05$). However, with so many significance tests and such large numbers, one should be wary of reading very much into differences of only marginal significance. Hence the 3% difference in those men who say they may reduce risk by relaxing more ($P = 0.046$) is regarded as negligible. All the other differences in this section of the questionnaire are extremely significant ($P < 0.001$), with the greatest differences of 14% for men with the "weight" question and 12% for women with the "exercise" question.

For the questions on health knowledge, correct responses are very common regarding milk, fried food, and dairy products, although more nonsmokers (9% for men; 4% for women) know about the benefits of skimmed milk ($P < 0.001$ for each sex). Only around 50% of all people know that bread and potatoes are not necessarily fattening, although there is little difference ($P < 0.025$) between the smoking groups after allowing for differences in age and social class. Knowledge of the relative merits of soft margarine and butter is slightly better, with nonsmokers "scoring" slightly better than smokers.

For the questions on health behavior over the last year, the percentages of nonsmokers who have tried to lose weight, eat less fat, eat less salt, and exercise more are considerably higher than the corresponding percentages for smokers. With the exception of the question on alcohol, all smoker vs nonsmoker differences are highly significant ($P < 0.001$).

Table 3 may also be used to compare the sexes. A greater percentage of women say that relaxing and losing weight will reduce their risk of a heart attack, know about the health benefits of skimmed milk, the nonfattening qualities of bread and potatoes, and have tried to lose weight and eat less fat in the past year. In no case do men score much more highly than women, although it is noticeable that more men know that soft margarine is better for them than butter, both among smokers and nonsmokers.

Table 4 compares smokers and nonsmokers on a large range of lifestyle variables, including some important aspects of diet. Means and standard errors are given, except in the cases of four questions which solicited yes/no responses, for which the percentage answering yes is shown. In every case there are some nonrespondents, for example 390 men and 661 women had missing total serum cholesterol, mainly from failure to obtain blood samples due to difficult peripheral veins (19). The ratio of the percentage of dietary energy from polyunsaturated and saturated fat (the P:S ratio) and alcohol consumption variables have been log transformed before P values were calculated, because both have very skewed distributions.

Smokers have lower values ($P < 0.01$) of HDL-cholesterol, body mass index, diastolic blood pressure (men only), and the P:S ratio, plus lower intakes of vitamin C, vitamin E, and fiber. They have higher values ($P < 0.01$) of serum total cholesterol (women only), triglycerides, and fibrinogen and a higher percentage of smokers find readymade food less salty, eat butter or hard margarine, and consume full-fat milk. Dietary cholesterol, alcohol, and total energy intake are also higher among smokers than they are among nonsmokers. All other differences are, at most, only of marginal significance (bearing in mind the large number of significance tests carried out).

Comparing the sexes in Table 4, men have higher values of triglycerides, body mass index, blood pressure, percentage taking full-fat milk, the P:S ratio, and daily intake of all nutrients except β-carotene. Women have higher total serum cholesterol, HDL-cholesterol, and fibrinogen and a higher percentage of women eat butter or hard margarine.

DISCUSSION

Table 3 seems to provide considerable evidence that smokers are less aware of health issues than nonsmokers. An alternative explanation is that smokers are simply less prepared to admit the health implications of what are commonly perceived as unhealthy practices, at least in regard to their own health. Since few smokers, if any, can be unaware of the risks of smoking itself, this is likely to explain at least some of the results. Either way, the conclusion that smoking is an accurate predictor of poor health behavior is sustained.

Table 4 shows that smoking is associated with several other factors that are generally considered to be precursors of poor health, particularly CVD. These are low HDL-cholesterol, P:S ratio, antioxidant vitamin, and fiber intake and high serum total cholesterol (among women), triglycerides and fibrinogen values, plus high intake of salt, butter or hard margarine, full-fat milk, dietary cholesterol, and alcohol. The majority of these differences involve aspects of diet. Of particular importance may be the antioxidant vitamins (β-carotene—the precursor of vitamin A, vitamin C, and vitamin E), which are believed to scavenge the free radicals that have been implicated in the development of coronary heart disease (CHD), cancer, and other diseases (20, 21). Since tobacco smoke itself contains a large number of free radicals (22), and absorption of vitamins from the diet may be less efficient in smokers (23), those who smoke have a higher than average requirement for antioxidant vitamins (8). Smoking may also affect taste perception (24), so conceivably fresh fruit and vegetables, the major source of vitamin C and an important source of β-carotene and fiber in the present study population (25), are less palatable. Alternatively, smokers may intrinsically like these foods less (regardless of their smoking habit) or feel less able to afford them. We have previously shown that low antioxidant vitamin and fiber intake is associated with prevalent CHD (26).

TABLE 4

Means (with Standard Errors) or Percentages of Lifestyle Variables by Smoking Group and Sex

	Men					Women				
	Nonsmokers (n = 2152)		Smokers (n = 2615)		P value[a]	Nonsmokers (n = 2744)		Smokers (n = 1980)		P value[a]
Total serum cholesterol (mmol/liter)	6.38	(0.026)	6.37	(0.024)	NS	6.52	(0.027)	6.68	(0.033)	***
HDL-cholesterol (mmol/liter)	1.39	(0.008)	1.33	(0.008)	***	1.72	(0.009)	1.60	(0.010)	***
Triglycerides (mmol/liter)	2.26	(0.031)	2.40	(0.029)	**	1.55	(0.020)	1.84	(0.026)	***
Fibrinogen (g/liter)	2.20	(0.016)	2.42	(0.014)	***	2.28	(0.014)	2.52	(0.018)	***
Body mass index (kg/m^2)	26.5	(0.07)	25.6	(0.07)	***	26.0	(0.09)	25.1	(0.10)	***
Systolic blood pressure (mm Hg)	134.1	(0.41)	133.8	(0.37)	NS	130.7	(0.38)	130.9	(0.48)	NS
Diastolic blood pressure (mm Hg)	85.1	(0.25)	83.6	(0.23)	***	81.3	(0.22)	80.7	(0.27)	*
% Inactive in leisure	17.1		19.8		*	18.2		19.2		NS
% Ready-made food less salty	25.1		36.4		***	23.5		37.7		***
% Eat butter/hard margarine	48.7		53.4		***	50.9		56.6		***
% Consume full-fat milk	67.2		71.8		**	60.5		66.3		**
P:S ratio	0.334	(0.0038)	0.297	(0.0030)	***	0.307	(0.0033)	0.265	(0.0034)	***
β-carotene (μg/day)	3280	(48.3)	3137	(43.3)	NS	3475	(42.5)	3195	(54.2)	*
Vitamin C (mg/day)	55.0	(0.48)	50.6	(0.41)	***	54.8	(0.46)	46.1	(0.51)	***
Vitamin E (mg/day)	7.85	(0.120)	6.80	(0.090)	***	6.89	(0.097)	5.82	(0.095)	***
Fiber (g/day)	22.3	(0.16)	20.2	(0.14)	***	20.2	(0.13)	17.5	(0.16)	***
Dietary cholesterol (mg/day)	368.2	(3.17)	417.7	(3.08)	***	322.4	(2.22)	354.7	(2.94)	***
Alcohol (g/day)	17.6	(0.45)	25.4	(0.54)	***	5.3	(0.14)	7.2	(0.22)	***
Total energy (kcals/day)	2240	(12.2)	2458	(12.6)	***	1734	(8.3)	1813	(11.7)	***

Note. P:S denotes polyunsaturated:saturated fat. β-carotene, precursor to vitamin A.

[a] P values are adjusted for age and occupational social class. For the P:S ratio and alcohol the P values were calculated after transformation. NS, $P > 0.10$.

* $0.01 < P < 0.05$.

** $0.001 < P < 0.01$.

*** $P < 0.001$.

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On the other hand, we have evidence that smokers have lower weight-for-height and have lower blood pressure (although not always significantly so). So smokers appear to avoid excess weight gain and to be less prone to hypertension. They are very similar to nonsmokers in terms of leisure activity (as self-perceived) and also, for men, in their total serum cholesterol measurement.

There is a considerable body of evidence that vitamin C intake and/or blood level are lower in smokers than nonsmokers (23, 27–31), in agreement with our present finding. Lower fiber intake among smokers has also been found before (29, 31, 32). There is wide agreement that smokers have lower β-carotene levels (33) although blood levels of vitamin A (retinol) are generally higher among smokers (34, 35). In the current study, daily consumption of β-carotene (Table 4) and vitamin A (results not presented) show the same relationships. Most studies of blood levels of vitamin E and smoking have found no relationship (34, 36), alth: :h lower vitamin E intake for smokers has been rep :d (8). A much smaller Scottish study (32) has previo..ly reported salt intake to be higher and the P:S ratio to be lower among smokers, and a U.S. study of a similar size to that analyzed here (31) found that smokers were less likely to drink low-fat milk, as did the British Health and Lifestyle Survey (37). Alcohol consumption has frequently been found to be higher among smokers (15, 37–39). Previous studies have found total energy intake to be either higher among smokers than non-smokers (29, 39) (as we have found) or about th: me in the two groups (32, 38, 40). The British Heal: and Lifestyle Survey (37) found that smokers eat less fresh fruit, salads, and brown or wholemeal bread, but eat more chips, in agreement with our findings. This survey also found that smokers less often eat breakfast, in agreement with the results of a large U.S. health promotion survey (15). In Scotland, smokers have been

found to eat less cereal-containing foods and polyunsaturated margarines (32), while in the United States, smokers have been found to eat less high fiber grains (31) and vitamin and mineral supplements (31, 41). Smokers have, however, been found less likely to eat snacks (15).

Turning now to the nondietary variables that are reported here (many of which may themselves be influenced by diet), blood total cholesterol has generally been found to be higher in smokers (39, 42–44) (only so for women in this study). In agreement with this study, HDL-cholesterol has previously been found to be lower (39, 42, 45), and triglycerides (42, 45) and fibrinogen (46) higher among smokers. The relationship between fibrinogen and several other lifestyle variables, including smoking, in the Scottish Heart Health Study is explored in detail elsewhere (47). Physical activity has previously been found to be either lower among smokers than nonsmokers (15, 48) or (as found here) about the same in the two groups (39, 49). Blood pressure has previously been reported to be lower in smokers (50). As in the current study, a study of Japanese men has reported lower diastolic blood pressure among smokers, but similar systolic blood pressure among smokers and nonsmokers (44). There is general agreement that smokers have a lower body weight than nonsmokers (15, 40, 51, 52).

Our study is, thus, generally in agreement with previous investigations, although we have the advantages of a large sample size, biochemical validation of smoking status, and data for both sexes. In fact we have found the effect of smoking on health awareness and lifestyle to be largely independent of sex, with a few detailed exceptions. In Scotland, middle-aged women are less likely to be smokers than are their male counterparts, particularly in the highest and lowest social class groups (Table 2). Women almost always have better health knowledge and are more prepared to act to improve their health (Table 3); one notable exception is that men are more aware of the possible health benefits of soft margarines. Of the lifestyle variables generally associated with good health, men did better only for the relative intake of polyunsaturated to saturated fats, consumption of soft margarine, total serum cholesterol and plasma fibrinogen levels, and the consumption of vitamin C, vitamin E, and fiber (Table 4). However, the apparent male advantage of taking more of these important vitamins and fiber may well be misleading, since men eat more in total than do women (as shown by the total energy consumptions in Table 4). When vitamin and fiber intakes are calculated relative to total energy consumption (so-called nutrient densities) to compare the quality of the diets, men have lower values of vitamin C, vitamin E, fiber, and β-carotene. Expressing these four nutrient intakes in relation to total energy intake does not affect their relation to smoking status, except that the higher β-carotene intake in nonsmokers reaches statistical significance ($P < 0.001$) for both sexes.

The nonsmokers in this study include both never-smokers and quitters. In an earlier paper (53) we investigated the relationship between diet and time since giving up smoking for the Scottish Heart Health Study. We found that, for men, energy-adjusted intakes of polyunsaturated fat, fiber, and the antioxidant vitamins increase and intakes of sugar and alcohol decrease with duration of exsmoking. The trends for women are less discernible because the diets of exsmokers more immediately resemble those of never-smokers. Four years after giving up tobacco the general dietary pattern of exsmokers is similar to that of never-smokers, for each sex.

We have shown that smoking status is related to several important aspects of health knowledge, behavior, and lifestyle. In particular, smokers are more likely to have a lower quality diet. Hence we conclude that smokers should be encouraged to alter their diet, especially to eat more fresh fruit and vegetables. With the everpresent need to target specifically for maximum effect, it is important that doctors and other health practitioners are aware of the need to give additional dietary advice to smokers. Health promotion material written for smokers might usefully emphasize the dietary message. This may be more readily taken on board because it can be phrased in a positive fashion, i.e., "eat more . . . ." It may also be appropriate for the tobacco industry to fund special dietary information material for its customers. The challenge for health educators and researchers would be to answer the question of whether it is possible to change the diet of smokers before giving up smoking, rather than after. All the same, the most important health message to give to smokers still is to give up smoking. For those who have difficulty giving up smoking, dietary and other general health information may be useful in promoting a greater consciousness of personal health, which may eventually lead to a greater desire to quit. Those proffering advice to smokers to quit should bear in mind other lifestyle factors. It may be useful to include a commitment to dietary improvement as part of a "smokers contract." A change to a healthier diet would, at least, be expected to help to ameliorate the toxic effects of tobacco smoking without any risk of unpleasant side effects.

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